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(54) Title: PROCESS AND BATTER FOR COATING VEGETABLE PIECES

(57) Abstract

A batter mix for coating vegetables prior to deep fat frying which results in a transparent coating, crisp exterior and a moist interior upon final frying, reduced sticking between pieces of vegetable, reduced oil content of the final product, improved product characteristics under heat lamp holding, and decreased expense of raw materials. A method for using the batter mix in the processing of potato products such as french fried potatoes which are cut, blanched, coated with the batter mix, par-fried and then frozen.

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TITLE OF INVENTION: PROCESS AND BATTER FOR COATING VEGETABLE PIECES

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DESCRIPTION

BACKGROUND OF THE INVENTION

Technical Field. The present invention generally relates to a batter and method for coating cut vegetable pieces before frying, and more particularly to a batter and method for coating french-fried potato pieces prior to their being fried.

Background: The high volume preparation of french fried potatoes has evolved into a rather exact science with parameters which have been highly refined through production improvements. The process of preparing french fried potatoes starts when the potatoes arrive at the processing plant. The potatoes are off-loaded from trucks and undergo an initial screening and washing, which removes some rocks and dirt clods. Further inspections and washings remove more foreign material, such as rocks, dirt clods and other objects, as well as damaged potatoes. After being washed, the potatoes are typically placed in a pressurizable container and subjected to steam for an amount of time appropriate to soften the outer layers of the potato. After a precise exposure to steam, the potatoes are typically subjected to a mechanical brushing operation, which removes the now softened outer layer of skin.

Alternately, the potatoes can be heated in hot water prior to peeling. After this peeling step, the potatoes are typically heated to a temperature of about 120° - 140°F. The purpose of heating the potatoes to this temperature is to provide for greater precision in subsequent cutting steps. When the potatoes are heated to the correct temperature, they are placed in a hydraulic cutter delivery system. In this system, the potatoes are carried along with a rapidly moving stream of water and impinge upon stationery cutting blades. The potatoes go through the cutting blades with their water of transportation, and exit the other side of the blades as french fries or other cuts.

The potatoes are separated from the water and the water returns to the hydraulic cutting system. The potatoes, which are now raw french fries, continue on to the next step of their processing. This step is typically to subject the potatoes to a steam or hot water blanch, for a time and temperature well known to those skilled in the art. The purpose of blanching is to deactivate enzymes, such as the peroxidase enzyme, which are present in the cells of the potato. Not deactivating enzymes such as this would result in discoloration in the potatoes in subsequent processing.

After blanching, the potato strips may be immersed in brine solution containing such ingredients as sodium acid pyrophosphate, sodium chloride, dextrose, and other ingredients. The "brine drag" step is optional.

Next, the french fries are typically subjected to a dehydration step in which they are partially dehydrated, with a loss in moisture of typically around 20%. After dehydration, it is common for the potatoes to be coated with a solution,

typically containing starch, called a batter. After being coated with the starch batter, the potatoes may be subjected to an "air knife", which blows off excess batter and evens out coverage. Next, the french fries typically go to a parfrying step, in which they are immersed in oil, which is kept at a temperature of from 325°F to 380°F, for 15-60 seconds. After the parfrying step, the french fried potatoes are frozen to about -25° to -30°F. While frozen, potatoes are packaged, stored, and distributed to the end users, who are either consumers or food preparation establishments, such as fast food restaurants, or other food establishments. The final step in preparing the frozen french fries for consumption is to immerse the frozen fries in hot oil at a temperature of 320° to 360°F for 2-5 minutes. Other means of preparation can include oven cooking and microwave cooking. This finishes the cooking of the french fries and browns them to a pleasant color. The texture which is desired at the end of this process is for the exterior of the potato to be browned and crisp, and the interior of the potato to be tender. Another step which is an often unavoidable part of the process is for the french fries to be held under a heat lamp for a period of time after their final cooking and before dispensing to the consumer.

The coating of the french fries with a starch solution is intended to serve several functions.

One function of the invention is to provide a batter which accomplishes all other purposes and is relatively invisible or transparent on the finished product.

Another function of the starch coating step is that the starch coating allows the outside surface of the potato to

become crisp, while the inside is less cooked.

Another function of the starch coating of french fry pieces is to cover the outer surfaces of the french fry and reduce moisture loss. The reduction of moisture loss after the final step of heating means that there is less evaporation of water from the surface of the potato. Such evaporating water causes cooling of the french fry due to evaporative cooling from the surface of the french fry. Sealing the surfaces of the french fry from water loss also allows them to be placed under heat lamps after frying and to retain their crispness and moisture content under the heat lamps for a longer period of time.

The preparation of frozen french fried potatoes is a high volume business involving very few steps and very few raw materials. An improvement of any steps of the process results in large savings to the manufacturer. Therefore, great efforts are directed at improving efficiencies. An important efficiency is in using lower cost raw materials than competitors to achieve the same results.

Another efficiency is reducing the amount of oil which is picked up by french fried potatoes. Additionally, consumers are increasingly concerned with the reduction of fat intake in their foods. For both of these reasons, it has become an important goal of the starch coating of french fries to achieve the other goals of starch coating while minimizing the pickup of oil from the parfrying step.

Another function is to coat the french fries with a material which will cause the french fries not to stick to each other in the parfrying step. If coated french fries do not stick to each other, they can be produced at a higher rate

of production. If the coated french fries stick to each other, this slows down the production and causes disruptions.

There is another requirement of french fry batter coatings, and that is that the batter does not cause the sticking of the french fries to each other when they are fried by the end user in hot oil.

Another purpose of coating the french fries in starch is to seal the exterior surface of the potato from pickup of oil from the parfrying step, and also from loss of moisture from inside the potato.

Another function of the starch coating step is to give all of the french fry surfaces a uniform exterior, so that they later cook and brown uniformly.

A coating for french fried potatoes which has been found to achieve at least some of these goals has been a mixture consisting primarily of potato starch. Both gelatinized and non-gelatinized mixtures have been used, but the typical mixture in use in production is a non-gelatinized mixture. Potato starch is obtained from the processing of french fries and other potato products. The starch results when potatoes impinge upon cutter blades and the cells of the tuber are ruptured in the cutting process. This liberates starch granules which are collected from the hydraulic cutter fluid. The starch granules are further refined before they are available for use in a starch mixture for coating french fries. Other starches or flours are also used. A flour is a starch-containing product made from grinding a seed, such as rice, wheat or corn. The original starch granules of such seeds generally survive the grinding process intact, and so a flour is mostly composed of starch granules.

Rice flour is made from milling the rice grain. The rice grain consists of about 70% - 80% starch, which exist as small granules. The rice grain is processed to make rice flour, with the rice starch granules surviving the process largely intact. There is a difference in price between potato starch and rice flour which results in potato starch costing 50-75 cents per pound, and rice flour costing 22-26 cents per pound. The inexpensive nature of rice flour has caused it to be included in various starch batter formulas as a filler. It is believed in the industry that rice flour added to the formula may add to the improved texture of the cooked product, but that too much rice flour in the formula results in decreased performance of the french fry batter.

Accordingly, it is an object of the invention to provide a batter which accomplishes all other purposes and is relatively invisible or transparent on the finished product.

Another object of the invention is that the batter allow the outside surface of the potato to become crisp, while the inside is less cooked.

Another object of the invention is to provide a batter which covers and seals the outer surfaces of the french fry and reduces moisture loss.

Another object of the invention is to provide a batter using lower cost raw materials than competitors to achieve the same results.

Another object is to reduce the amount of oil which is picked up by french fried potatoes from the parfrying step.

Another object is to reduce sticking of french to each other in the parfrying step.

Another object of the invention is reduce the sticking of

the french fries to each other when they are fried by the end user in hot oil.

Another object of the invention is to seal the exterior surface of the potato from pickup of oil from the parfrying step, and also from loss of moisture from inside the potato.

Another object of the invention is to give all of the french fry surfaces a uniform exterior, so that they later cook and brown uniformly.

Another object of the invention is to provide a batter which results in a more effective sealing of the surface of the french fried potato or other cut vegetable piece. The improved sealing of the surface would result in less evaporative cooling, and the ability to be kept under heating lamps for a longer period of time.

A further object of the invention is to provide a coating batter which results in a uniform color of the finished product and texture on the surface of the french fry, as well as in the interior of the french fry.

DISCLOSURE OF INVENTION

According to the present invention, the foregoing and other objects and advantages are attained by an aqueous batter formulation which is applied to cut vegetable pieces, such as french fried potato pieces, after they have been blanched and before they are par fried. The batter mix includes:

12% - 40% high amylose rice flour

up to 28% starch

up to 8% salt

up to 1% sodium acid pyrophosphate
up to 1% sodium bicarbonate
up to 1% food gum
up to 2.8% flavor or color additive

As noted in the above formulation, the batter mix can contain up to 28% starch. This starch component of the formulation can consist of wheat starch, wheat flour, modified corn starch, dextrin, potato starch, other starches or mixtures of these or other starches.

The basic formulation listed above includes 12% to 40% of a high amylose rice flour. What is referred to as high amylose rice flour is any rice flour in which the starch granule of the rice flour consists of at least 20% amylose. A rice flour which has been found to consistently meet this requirement is rice flour made from long grain rice.

This batter mixture can be applied during the processing of a variety of vegetables, including but not limited to, potatoes. Other vegetables could include turnips, rutabagas, Jerusalem Artichokes, squash, sweet potatoes, beets, carrots, onions, parsnips, broccoli, okra, peppers, mushrooms, cauliflower, or any other vegetable which is cut and frozen. The formulation has been particularly developed using potatoes in a french fry cut, but other cuts of potatoes or other vegetables in a variety of cuts could benefit by the use of the invention.

When the batter mix is mixed with water as described above and applied to cut vegetables, such as french fry potatoes, which are subsequently par fried and frozen, the dry batter mix makes up less than 17% of the weight of the frozen vegetable. When the dry batter mix described above is applied

to cut vegetables, such as french fry potatoes, which are subsequently fried and frozen, the use of the batter results in the frozen product containing less than 7% by weight of oil from the parfrying step.

The invention also consists of a method for making deep fat fried vegetable products. The method consists of the steps of (1) cutting the raw vegetable into pieces; (2) blanching the raw vegetable pieces; (3) partially drying the vegetable pieces; (4) coating the cut vegetable pieces with an aqueous batter formulation; (5) parfrying the coated vegetable piece in hot oil; and (6) freezing the coated vegetable piece. Additionally, a brine drag step can be added after blanching of the vegetable pieces. The drag step subjects the potato strips to a 165°F brine immersion which is comprised of .01-.03% salt and .02-.04% SAPP, for a period of 20-30 seconds.

In the process described above, the batter formulation consists of 12% to 40% high amylose rice flour, up to 28% starch, up to 8% salt, up to 1% sodium acid pyrophosphate, up to 1% sodium bicarbonate, up to 1% food gum; up to 2.7% flavor additive, and the remainder of the batter made up of water.

The starch component of the above formula can consist of wheat starch, wheat flour, modified corn starch, dextrin, potato starch, or other starches, or mixtures of those or other sources of starch. In the method described above, using the formulation as described above, the high amylose rice flour is a rice flour which contains greater than 20% amylose. It has been found that rice flour made from long grain rice generally satisfies this condition. In the method of making deep fat fried vegetable products described above, the batter which is used to coat the cut vegetable product comprises less

than 17% of the weight of the final coated vegetable product. This weight percentage refers to the product as it is frozen, not the product after final frying by the consumer. This method results in less than 7% by weight of the final coated fried and frozen product consisting of oil. This percentage refers to oil which is picked up in the parfrying portion of the process.

In the method for making deep fat fried vegetable products which is described above, the batter formulation is mixed with water so that the batter comprises 36% to 44% of the mixture.

The method for making deep fat fried vegetables which is described above has particular utility when used with potatoes and with a french fry cut, but is also useful with other cuts of vegetables and with other vegetables such as turnips, rutabagas, Jerusalem Artichokes, squash, sweet potatoes, beets, carrots, onions, parsnips, broccoli, okra, peppers, mushrooms, cauliflower, or any other vegetable which is cut and frozen.

The method and batter mix of the invention, using a mixture composed primarily of rice flour and also other sources of starch, as well as salt, sodium acid pyrophosphate, sodium bicarbonate, food gum and flavoring, results in a batter for coating cut french fried potatoes or other vegetable which forms an invisible or transparent coat on the finished product, allows the outside surface of the potato to become crisp, while the inside is less cooked, covers and seals the outer surfaces of the french fry and reduces moisture loss, uses lower cost raw materials than competitors to achieve the same or superior results, reduces the amount of oil which is picked up by french fried potatoes from the

parfrying step, reduces sticking of french to each other in the parfrying step, reduces the sticking of the french fries to each other when they are fried by the end user in hot oil, seals the exterior surface of the potato from pickup of oil from the parfrying step, and also from loss of moisture from inside the potato, gives all of the french fry surfaces a uniform exterior, so that they later cook and brown uniformly, is a more effective sealing of the surface of the french fried potato or other cut vegetable piece, which results in less evaporative cooling, and allows the french fry to be kept under heating lamps for a longer period of time, and which provides a coating batter which results in a uniform color of the finished product and texture on the surface of the french fry, as well as in the interior of the french fry.

Still other objects and advantages of the present invention will become readily apparent to those skilled in this art from the following detailed description, wherein we have shown and described only the preferred embodiment of the invention, simply by way of illustration the best mode contemplated by us of carrying out our invention. As will be realized, the invention is capable of modifications in various obvious respects, all without departing from the invention. Accordingly, the description is to be regarded as illustrative in nature, and not as restrictive.

BEST MODE FOR CARRYING OUT INVENTION

In the preferred mode of the invention, raw potatoes are washed, sorted, peeled, and cut into french fries in a hydraulic cutting system. Before being cut, the potatoes are

heated to about 120° - 140°F. After being cut, the french fry pieces are separated from the water of the hydraulic cutting system. The water of the hydraulic cutting system is returned for reuse in that system, and the french fries continue to the next step. The french fries are subjected to heat, either by the use of steam, or by the use of hot water, for approximately 5 minutes at 165°F in order to inactivate enzymes which are present in the potatoes.

After blanching, the french fried potatoes are dried, with an optional salt drag step, then they are dipped in the batter mixture of the invention. This batter is a dry mix which is blended with water to result in a slurry which has the desired viscosity.

The viscosity of the batter mixture is measured using an S90/ Zahn #5 viscosity cup. This is an instrument which is commonly used in the industry. It consists of a cup which has a precisely sized hole opening in the bottom of the cup. A known volume of solution is placed in the cup, and the amount of time that it takes to drain out the hole in the bottom of the cup is measured. A more viscous fluid takes more time to drain out of the cup, and a less viscous fluid, such as water, drains out of the cup more quickly. The preferred viscosity measurement of the batter mixture combined with water is 4.92 to 7.3 seconds to drain from the number 5 Zahn viscosity cup. The batter mixture is mixed with water to achieve this consistency and kept in a tank for use on the french fried potatoes. The batter mix combined approximately 40:60 with water will be at the desired consistency, with a ration of 38:62 being the preferred mode. The temperature of this solution is kept at from 50° to 70° by the water temperature

of the water component of the mixture. The gel temperature of the rice flour is about 165°F, and the gel temperatures of the other ingredients are 180° - 181°F for the wheat flour, 180° - 186°F for wheat starch, and about 165° for cornstarch. Therefore, the components of the mixture remain ungelatinized at the time of application.

After the french fries are coated with the batter mixture, they are moved to the parfrying step. In the parfrying step, the potatoes with their batter coating are parfried for 30 to 90 seconds in oil at about 370°F.

The parfried french fries are then frozen, packaged, and stored. In their frozen state, they are shipped to points of final preparation, which can be the consumer, fast food restaurants, other restaurants, or other places which cook french fries from frozen fries. At the time and place of final cooking, the frozen french fries are preferably immersed in hot oil for two to five minutes at approximately 370°F. After this period of cooking, the french fries may be dispensed for consumption, or they may be held under heat lamps for a period of time before consumption.

Our batter mixture and method are quite different from batter mixtures and methods now in use by commercial operations. Currently used batter mixtures are primarily of composed of potato starch, wheat flour or other starch sources. Some batter formulations contain up to 12% rice flour in the aqueous batter mixture. Higher percentages of rice flour have been thought to ruin the french fry batter. The batter formulation of our invention is comprised primarily of rice flour. The particular rice flour utilized is long-grain rice flour, which has a typical amylose content of 22% to 24%,

and is of a particle size such that at least 98% of the rice flour passes through a no. 100 sieve, and no more than 45% of the rice flour passes through a no. 200 sieve. These sieve characteristics reflect the fact that a granule of rice starch is much smaller than a granule of potato starch. Potato starch granules are typically 100 micrometers (µm) in diameter. Rice granules, however, range from three to eight µm in diameter. The amylose content of long grain rice flour is higher than the amylose content of either medium or short-grain rice flour.

Based on these properties of rice flour and the following further information, the inventors suggest the following mechanism to explain the success of their formulation which utilizes rice flour at a concentration previously believed to be detrimental to the quality of the product.

When the potato is cut into french fry pieces, many cells along the plane of each cut are cut open by the blade, exposing the starch granules inside the cells. The potato tuber also contains a variety of vascular structures and capabilities. These structures allow transport of nutrients and material from one part of the tuber to another. It is well known that if a potato is injured or cut while it is in storage, it has the capability of repairing the injury by covering the area with scar tissue, and then rebuilding cells or corky tissue under the scar tissue. This reparative capability is supported by vascular structures and capabilities which allow the transport of moisture, nutrients, energy storage compounds, and other metabolites from one parto of the potato to another part. When a potato is cut into french fries, the vascular structures between the cells are

exposed. The exposure of this network of vascular structures, as well as the exposed nature of many of the cells along the plane of the cut, provide a route for water to leave the potato piece, and also provide surface area and porosities to absorb oil.

Like most plant starches, rice flour starch is composed of amylose and amylopectin. The ratios of these two components are controlled largely by the genetics of the plant involved. The molecular structure of amylose is linear, and it consists of D-glucose monomers repetitively linked at their α-1,4 positions. As many as 150,000 such D-glucose monomers can be linked together in one long chain. Amylopectin has a linear structure identical to that of amylose, but in addition to the α-1,4 glycosidic linkages, the amylopectin molecule periodically have a linkage from a D-glucose molecule via an α-1,6 glycosidic link. This type of bonding encourages the development of dendrydic or branched macromolecular structure. Molecular weights for amylopectin vary widely and often exceed 500,000.

The ratio of amylose to amylopectin has been found to affect several properties which come into play when coating a food product with a starch layer.

When starch is exposed to water, especially when this is accompanied by gentle heat and agitation, the starch granules begin to imbibe water. During this hydration process, the crystalline structure of the starch granule begins to swell and individual strands of amylose and amylopectin begin to migrate from the starch granule. As more heat is applied, the starch granule eventually loses its crystalline properties and a paste is formed as the starch granule dissolves. This

overall process is called gelatinization. It has been found that the percentage of amylose in a starch granule has an effect on the gelatinization temperature of the starch. Due to interactions between amylose molecules, the higher the percentage of amylose, the higher the temperature at which the starch gels, or dissolves.

In a starch solution containing amylose and amylopectin strands, the amylose strands have the characteristic of re-aggregating as the solution is cooled. This is called retrogradation. Retrogradation occurs between amylose molecules only and not appreciably between amylopectin molecules. It is, therefore, not surprising that the content of amylose in starch grains relates to the starch's characteristic of retrogradation. Starches having a higher proportion of amylose thus gel or dissolve at higher temperatures, and when they retrogade, it is into a more stable and durable form than a similar starch solution with a lower amylose content.

Another factor which affects retrogadation is the size of the amylose molecule. Amylose molecules are identified by the number of glucose units which are attached in the basically linear formation of an amylose molecule. Potato starch can have 2,000 to 4,000 glucose units in one strand of amylose. Corn starch typically has 300 to 450 glucose units in a strand of amylose. Rice amylose typically is composed of approximately 1,000 glucose units. It has been found that amylose containing more than 2,000 glucose units and less than 30 glucose units displays poor properties of retrogradation. Starches with fewer glucose units than potato starch, and more glucose units than the 30 glucose units of dextrins, display

improved retrogadation properties. Thus, potato starch amylose molecules have a low tendency to retrogradation, and rice amylose molecules have a better tendency to retrogradation.

The properties of amylose content, starch granule size, and the number of glucose units in starch granules come into play when comparing the coating and sealing abilities of a potato starch mixture and a rice flour mixture. Both are mixtures of starch particles which will gel when heated and retrograde when cooled. The rice flour is composed of starch granules which are as much as one hundred times smaller than the potato granules. Although some rice flours have less amylose content than potato starch, the rice flour used by our invention has a similar amylose content as potato starch. The amylose of rice flour has a more optimum number of glucose units for retrogadation than does potato starch. It is believed that these characteristics of retrogradation contribute to the improved results of our invention. By the presence of adequate quantities of amylose for reassociation after gelation, and by the fact that those amylose molecules are of a more desirable size in glucose units for retrogradation, it is believed that the result is a firmer and more durable starch coating forming over the outside surface of french fries than that formed by a batter consisting primarily of potato starch.

The preferred batter mix of the present invention includes the following ingredients in the following weight per cents, as percentages of an aqueous mixture. The batter mix can also include other optional ingredients to achieve a particular desired property.

TABLE 1

INGREDIENT	WEIGHT RANGE
Long grain rice flour	12-40%
Starch (wheat, wheat flour, dextrin, potato starch or modified corn starch)	up to 28%
Salt	up to 8%
Sodium acid pyrophosphate	up to 1%
Sodium bicarbonate	up to 1%
Food gum	up to 1%
Flavor	up to 2.8%
Water	the remainder

Although this basic formula can be modified extensively to achieve the specific requirements of a particular product, an ideal formula for practicing this invention to achieve invisibility and all of the other desirable features of a coating batter consists of a mixture containing the following ingredients in the percentages shown in Table 2 below.

TABLE 2

INGREDIENT	WEIGHT RANGE
Long grain rice flour	24%
Wheat starch	8%
Dextrin	4%
Salt	3.34%
Sodium acid pyrophosphate	.36%
Sodium bicarbonate	.26%
Food gum	.02%
Flavor	.02%
Water	60%

A batter of this formulation was applied to french fried potato cuts after blanching, which were then parfried at 380°F for 55 seconds. It was found that the finished product (after freezing), consisted of 6.8% oil, which was picked up from the parfrying step. This compares very favorably with the oil pickup of competitive formulations in commercial use. This formulation also resulted in 17.1% of the weight of the finished product being due to batter on the outside of the french fries. The batter was mixed approximately 40:60 with water and the specific viscosity of the batter as applied to the french fries was 7.04 seconds on the #5 Zahn viscosity cup.

When the frozen product was subjected to a finish cook in 370°F oil for 2 minutes and 55 seconds, the batter on the cooked french fries exhibited a flat and tight coverage. This means that there were no bubbles or crusts evident on the fries. The batter coating was almost invisible. The fries when broken in half by hand had a firm break, indicating a good external texture. The "toothpack", which refers to the

characteristics of the fries for accumulating on the consumer's teeth, was described as "meltaway", the optimum quality for toothpack. The "chewdown", which refers to mouth feel of the product, or how it feels when chewed by the consumer, was good. Chewdown evaluates both the external and internal texture. The product exhibited much better than average holding characteristics, even gaining in crispness while held under the heat lamp. In this respect, the product was better than competitors products, and much better than french fries without batter. Holding characteristics are evaluated by holding the product under a heat lamp for 10 minutes, and then breaking the fry in two. A crisp sounding break is desirable after the heat lamp step. The color was zero on the Munsell Color chart, which was the optimal desired color for this test, and brighter in appearance than potatoes fried without batter. The product also had better flavor than french fries processed without batter.

Various formulations of the food batter were tested utilizing french fried potatoes as the vegetable to be coated. In the first example, described in Table 3 below, potatoes were prepared as described above. They were preheated before cutting, then cut and blanched as described above. Then they were coated with the starch formulation for each example, parfried as described above, and frozen.

Three other variations of the basic formula are also illustrated in table 4, 5 and 6 below.

TABLE 3

INGREDIENT	WEIGHT RANGE
Long grain rice flour	23%
Wheat starch	7%
Dextrin starch	.4%
Salt	5.34%
Sodium acid pyrophosphate	.36%
Sodium bicarbonate	.26%
Food gum	.02%
Flavor	.02%
Water	60%

A batter of this formulation was applied to the french fry potato cuts after blanching, and it was then parfried at 380°F for 55 seconds. It was found that the finished product (after freezing) consisted of 7.23% fat, which was picked up from the parfrying step. This formulation also resulted in 14.7% of the weight of the finished product being due to batter on the outside of the french fries. The specific viscosity of the batter as applied to the french fries was 6.56 seconds on the #5 Zahn viscosity cup.

When the frozen product was subjected to a finish cook in 370°F oil for 2 minutes and 55 seconds, the batter on the cooked french fries exhibited a flat and tight coverage. The fries when broken in half by hand had a firm break, indicating a good external texture. The "toothpack" was described as "good". The "chewdown" was good. The product exhibited above average holding characteristics. The color was zero on the Munsell Color chart, which was the optimal desired color for

this test.

TABLE 4

INGREDIENT	WEIGHT RANGE
Long grain rice flour	17.6%
Wheat starch	12%
Dextrin starch	3.2%
Modified corn starch	3.2%
Salt	4.46%
Sodium acid pyrophosphate	0.3%
Sodium bicarbonate	0.22%
Flavor	0.04%
Water	60%

A batter of the formulation shown in Table 4, was applied to french fry potato cuts after blanching, and they were then parfried at 380°F for fifty-five seconds. It was found that the finished product (after freezing) consisted of 6.19% fat, which was picked up from the parfrying step. This formulation also resulted in 10% of the weight of the finished product being due to batter on the outside of the french fries. The specific viscosity of the batter as applied to the french fries was 4.92 seconds on the #5 Zahn viscosity cup.

When the frozen product was subjected to a finish cook in 370°F oil for 2 minutes and 55 seconds, the batter on the cooked french fries exhibited a flat and tight coverage. The fries when broken in half by hand had a firm break, indicating a good external texture. The "chewdown" was rated as "moderately hard crisp." The product exhibited average holding characteristics.

TABLE 5

INGREDIENT	WEIGHT RANGE
Long grain rice flour	32%
Wheat flour	4%
Salt	3.4%
Sodium acid pyrophosphate	.28%
Sodium Bicarbonate	.2%
Food gum	.1%
Water	60%

The formulation shown in TABLE 5 had a viscosity reading of 7.3 seconds on the #5 Zahn viscosity cup. This formulation resulted in an oil pickup of 5.52% and a batter pick up of 16.8% on the final product.

When the frozen product was subjected to a finish cook in 370°F oil for 2 minutes and 55 seconds, the batter on the cooked french fries exhibited a flat and tight coverage. The fries when broken in half by hand had a average crispness, indicating an average and acceptable external texture. The "toothpack" was described as "slight", indicating that there was some tendency for accumulation on the consumer's teeth. The "chewdown" was rated as "tender crisp".

TABLE 6

INGREDIENT	WEIGHT RANGE
Long grain rice flour	38.4%
Salt	1.16%
Sodium Acid pyrophosphate	.28%
Bicarbonate of soda	.2%
Flavor	.001%
Water	60%

The formulation of TABLE 6 had a viscosity of 6.8 seconds on the #5 Zahn viscosity cup. This formulation resulted in 6.5% oil pickup in the final product, and 16.9% batter pickup in the final product. A salt drag was used in this test run, and additional salt was added in that step.

When the frozen product was subjected to a finish cook in 370°F oil for 2 minutes and 55 seconds, the batter on the cooked french fries exhibited a flat and tight coverage, but with some surface blisters. The fries when broken in half by hand were rated as being "sandy hard crisp", indicating an acceptable external texture. "Sandy" means the texture was gritty. A "hard crisp" has more crunch than a "tender crisp". The "chewdown" was "good". The color was 0.5 on the Munsell Color chart, which indicates a slightly darker color when compared to a rating of zero.

While there is shown and described the present preferred embodiment of the invention, and several variations on the basic formulation, it is to be distinctly understood that this invention is not limited to these formulations, but may be variously embodied to practice within the scope of the

1. An aqueous batter mix for coating vegetables or pieces thereof, said batter mix comprising:

12-40% by weight of high amylose rice flour;

up to 28% by weight of starch;

up to 8% by weight of salt;

up to 1% by weight of sodium acid pyrophosphate;

up to 1% by weight of sodium bicarbonate;

up to 1% by weight of food gum;

up to 2.8% by weight of flavor or color additive; and

water to comprise the remainder of said batter mix.

2. An aqueous batter mix for coating vegetables or pieces thereof, said batter mix comprising:

13-25% by weight of ungelatinized high amylose long grain rice flour;

up to 20% by weight of ungelatinized potato starch;

2-6% dextrin;

up to 3% by weight of salt;

up to 1% by weight of sodium acid pyrophosphate;

up to 1% by weight of sodium bicarbonate;

up to 1% by weight of food gum;

up to 2.8% by weight of flavor or color additive; and

water to comprise the remainder of said batter mix.

3. A method for making coated vegetable products which comprises:

cutting the raw vegetable into pieces;

blanching the raw vegetable pieces;

partially drying the vegetable pieces;

mixing an aqueous batter formulation having:

12-40% by weight when mixed in an aqueous solution of high amylose rice flour,

up to 28% by weight when mixed in an aqueous solution of starch,

up to 8% by weight when mixed in an aqueous solution of salt,

up to 1% by weight when mixed in an aqueous solution of sodium acid pyrophosphate,

up to 1% by weight when mixed in an aqueous solution of sodium bicarbonate,

up to 1% by weight when mixed in an aqueous solution of food gum,

up to 2.8% by weight when mixed in an aqueous solution of flavor or color additive, and

water to comprise the remainder of said batter formulation;

coating the cut vegetable piece with an aqueous batter formulation;

parfrying the coated vegetable piece in hot oil; and

freezing the coated vegetable piece.

4. The batter mix of Claim 1, or the method of Claim 3 wherein the starch component is selected from the group consisting of wheat starch, wheat flour, modified corn starch, potato starch, dextrin, and mixtures thereof.

5. The batter mix of Claim 1, or the method of Claim 3 wherein the starch in the high amylose rice flour contains at least 20% amylose.

6. The batter mix of Claim 1, or the method of Claim 3 which further comprises: rice flour made from long grain rice.

7. The batter mix of Claim 1 or 2, or the method of Claim 3 wherein the batter mix is combined with water so that the resultant mixture contains 36-44% batter mix.

8. The batter mix of Claim 1 or 2, or the method of Claim 3 said batter formulation contains up to 10% of a flavor or coloring additive.

9. The batter mix of Claim 1 or 2, or the method of Claim 3 which results in an invisible or transparent coating on said vegetable piece.

10. The method of Claim 3 in which a salt drag is used, with said salt drag step comprising a solution at 150-170°F, for 20-30 seconds, containing .01-.03% salt and .02-.04% sodium acid pyrophosphate.

INTERNATIONAL SEARCH REPORT

International application No.
PCT/US97/08425

A. CLASSIFICATION OF SUBJECT MATTER

IPC(6) :A21D 10/04
US CL :426/102, 552, 637
According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

U.S. : 426/102, 552, 637

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

APS search terms: rice, flour, high amylose, coating, batter

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y	US 3,597,227 A (MURRAY et al) 03 August 1971, col. 2, lines 39-73.	1-24
Y	US 5,431,944 A (MELVEJ) 11 JULY 1995, col. 5, lines 26-70 and col. 6, lines 1-50.	1-24
Y	US 5,520,937 A (YASOSKY et al) 28 April 1996, col. 3, lines 35-50.	1-24

☐ Further documents are listed in the continuation of Box C. ☐ See patent family annex.

* Special categories of cited documents:

"A" document defining the general state of the art which is not considered to be of particular relevance

"E" earlier document published on or after the international filing date

"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)

"O" document referring to an oral disclosure, use, exhibition or other means

"P" document published prior to the international filing date but later than the priority date claimed

"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art

"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
22 AUGUST 1997	26 SEP 1997
Name and mailing address of the ISA/US Commissioner of Patents and Trademarks Box PCT Washington, D.C. 20231 Facsimile No. (703) 305-3230	Authorized officer *Debbie Thomas* HELEN PRATT Telephone No. (703) 308-1978